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TOTAL PRODUCTIVE MAINTENANCE (TPM): A PROPOSED MODEL FOR INDIAN SMES

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ABSTRACT

The systems like Total productive maintenance (TPM), Total quality management (TQM) and Just-in-time (JIT) have been implemented mainly in large industries. These systems can also be implemented in small and medium enterprises (SMEs) in developing countries. More than 75% of total industries in India are of Small and Medium size industries (Jutla et al., 2002). These are the heart of the large industries because large industries purchased most of the parts or component from small and medium size industries. Now-a-days, customer satisfaction is the challenge of large industries which can be achieved when parts produced in SMEs are of good quality, available at the right time and at low prize. In this paper, Authors are discussing the needs of TPM implementation in Indian SMEs and its effects on productivity, quality of product, culture of the organization, maintenance activity etc. The outcomes of literature of some case studies were kept in mind that all these show that the implementation of TPM in SMEs is still very low or negligible in India. Therefore, more effort should be given in developing a better model or there is a need to develop a proposed model for TPM implementation in SMEs. Finally, a TPM implementation methodology is proposed. In this paper, Authors have revised some pillars. This proposed model for SMEs also includes total 8 pillars as Autonomous maintenance, Continuous improvement, Maintenance Planning & Mobile Maintenance, Quality Maintenance & Mock Drill, Maintenance Management, Education, Training & Knowledge Management, Administration & Office TPM and Safety, Health & Environment. Authors have made its foundation strong by adding another 5S for workers along with 5S for work place and also add another 5Z (Zero Unplanned Downtime, Zero speed loss, Zero Rework, Zero Negligence and Zero Tolerance) in the foundation. TPM is not merely a concept but a practical and down-to-the-earth technique for achieving significant savings and increase in profits.

KEYWORDS: TPM, SMEs, Large Industry, TPM Pillars, Major Losses, Maintenance, OEE

INTRODUCTION

Small and medium enterprises (SMEs) are considered as the backbone of economic growth in all countries because they account for more than 75 percent of global economic growth (Jutla et al., 2002). SMEs are contributing in providing job opportunities and also act as a supplier of goods and services to large organizations. SMEs can be defined by a number of factors and criteria, such as Investment, location, size, age, structure, organization, number of employees, sales volume, worth of assets, ownership through innovation and technology (Rahman, 2001). In India, SMEs managers face a lot of pressures to reduce costs of product, improve product quality, and deliver goods and services on time. Moreover, Indian SMEs operate generally in an unsupportive environment (Singh et al., 2006). The India has evolved as an extensive institutional network over time for the promotion of small and medium scale enterprises (SMEs). This network extends from the national to state and district levels. Different institutions are Small Industries Development Organization (SIDO),

Small Industries Service Institutes (SISIs), National Small Industries Corporation (NSIC), National Institute of Small Industries Extension Training (NISIET), Small Industries Development Corporation (SIDC) and State Financial Corporation and District Industries Centers (SFC&DIC). These institutions are helping small firms in several functions including marketing, exporting, importing, adopting technology and the like. To meet the challenges of international competition and to promote exports of SSI products, the following promotional schemes are being implemented:

- Small Industries Development Bank of India implements schemes for technology development and modernization of SME units.
- SMEs organize workshops on awareness about quality and ISO-9000 certification.
- Establishment of tool rooms helps in providing tooling, dies, moulds and fixtures to small-scale units at a very low price to enable SMEs to produce quality goods to meet the requirements of the customers.
- Process-cum-Product Development Centers take up jobs from SMEs for specific product development as well process development to improve the quality of products, reduce cost of product and enhance marketability of goods.
- The government helps SMEs in marketing their products by organizing international exhibitions, sponsoring delegation from different SSI sectors to MRR

The limit for investment in plant and machinery / equipment for manufacturing / service enterprises, as notified, vide S.O. 1642(E) dtd.29-09-2006 is given in table 1:

Table 1: Classification of Enterprises on the Basis of Investment on Plant, Machinery and Equipments in Manufacturing and Service Sector in India

Manufacturing Sector	
Enterprises	Investment in plant & machinery
Micro Enterprises	Does not exceed twenty five lakh rupees
Small Enterprises	More than twenty five lakh rupees but does not exceed five crore rupees
Medium Enterprises	More than five crore rupees but does not exceed ten crore rupees
Service Sector **	
Enterprises	Investment in equipments
Micro Enterprises	Does not exceed ten lakh rupees
Small Enterprises	More than ten lakh rupees but does not exceed two crore rupees
Medium Enterprises	More than two crore rupees but does not exceed five core rupees

***Investment limit in Plant & Machinery ** Investment limit in equipments**

Equipment maintenance is still at low priority in most of the manufacturing industries and also lack of knowledge about equipment maintenance is one of the main obstacles (Ahmed et al., 2004). Plant Maintenance and maintenance of equipments may vary with the size of an organization; type, age and complexity of equipments; knowledge and understanding of managers/supervisors; skill levels and attitude of operators; and firms strength for investment. Skill level difference must also consider when implementing TPM (Proma et al., 2010). SMEs in both countries are facing challenges of building product quality, cost and Technology (Singh et al., 2010). SMEs have some distinct limitations. Most of the Small industries are owner-cum-manager centered where a systematic approach is very much lacking. Further, in a large

number of SMEs, owners are in management by heredity, not by quality. SMEs having some potential advantages to give training to their managers and workers in their workplace, because each manager of an SMEs has a very few numbers of manpower and they are working very close to one another. The scope of team formation and participation in SMEs is easier than in large companies. Therefore, it is very easy and cheap to train and educate their employees and the amount of time required to cascade training to lower levels is much shorter than that of large companies (Yusof and Aspinwall, 2000). However, as SMEs have a shortage of necessary learned manpower (Nwankwo, 2000), and run under very constrained funding (Gustafsson et al., 2001), A set of typical problems and limitations in SMEs are listed below.

- Lack of understanding about improvements of capacity and capability;
- Preference given to breakdown maintenance system instead of preventive maintenance;
- Traditional work divisions or ineffective organizational structure;
- Level of skill/knowledge of manpower
- Poor condition of equipments and poor maintenance work of these equipments;
- Lack of human resources both in terms of number and skill (expertise);
- Lack of in-house training facilities;
- Lack of time and interest to send employees elsewhere for their training and development;
- Emphasis on short-term gains and lack of long-range vision and plans;
- Lack of participation of non-manufacturing units such as administration, marketing, purchasing and maintenance;
- Lack of modern technology and understanding the role of technology;
- Shortage of funding for investment; and
- Lack of time to think,

TOTAL PRODUCTIVE MAINTENANCE (TPM)

Total productive maintenance (TPM) originated in Japan in 1971 as a method to improve machine Availability through better utilization of maintenance and production resources. Total Productive Maintenance **(**TPM), is a concept that originated in Japan and was developed by Japan Institute of plant Maintenance (JIPM). In TPM, the machine operators must be trained to perform daily or simple maintenance work whereas in most of the traditional production the operators are not viewed as a member of the maintenance team. The main contribution of TPM implementation is teamwork and maintenance practices (Rolfsen and Langeland, 2012). Preventive maintenance was introduced into Japan. Nippondenso, which is the part of Toyota, was the first company in Japan to introduce plant wide preventive maintenance in 1960. TPM implementation could not be successful in many manufacturing industries due to many obstacles or problem (Majumdar and Manohar, 2012). In preventive maintenance, the operators were producing goods on machines and the maintenance personal was busy in maintaining those machines. Autonomous Maintenance is one of the features of TPM. The implementation of all the 7 steps of autonomous maintenance in any organization will benefit (Lazim et al., 2009). A better communication and teamwork are playing vital role in establishing Autonomous maintenance team

Chand and Shirvani, 2000). Total Productive Maintenance**,** shortly termed as TPM, is the originated and developed by Japan Institute of plant Maintenance (JIPM). TPM project is very strongly linked concept to the direct participation of workers; Education & Training program (Ferrari et al., 2002). TPM is used to achieve high level of productivity through total participation of all the employees of the organization. TPM has basically 3 goals - Zero Defects, Zero Unplanned Equipment Failures and Zero Accidents. TPM is a management process developed for improving productivity by making processes more reliable and less wasteful. TPM implementation in any organization enhances the OEE by increasing equipment availability, decreasing rework, rejection. Overall productivity of industry is also increased by TPM implementation (Wakjira et al., 2012).TPM is an extension of TQM (Total Quality Management). The objective of TPM is to maintain the plant or equipment in good condition without interfering with the daily process. To achieve this objective, preventive, predictive and autonomous maintenance is required (Lazim et al., 2009). By using the philosophy of TPM we can minimize the unexpected failure of the equipment. To implement TPM the production unit and maintenance unit should work jointly (Jain et al., 2012). TPM identifies the six big losses namely set-up and initial adjustment time, equipment breakdown time, idling and minor losses, speed losses, start-up quality losses, and in process quality losses. Operators in the shop floor must also involve in maintenance operation and solve problems as earlier as possible and eliminate most of the losses or waste like time waste, downtime losses etc. in autonomous maintenance (Almeanazel and Taisir, 2010). There are various obstacles affecting the successful implementation of TPM in Indian manufacturing organizations (Ahuja and Khamba, 2008d). Most important obstacles or barriers in implementing TPM are lack of senior management support, union worker resistance, tight budget pressure of workload, organizational change etc.(Cook, 2000).

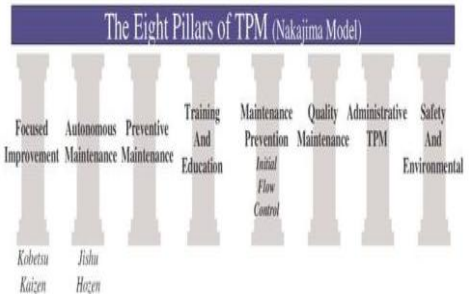
LITERATURE REVIEW

Consumer needs, technology and competitive paradigms are continuously changing in this global competition. In most of the studies, competitiveness of an organization is measured in terms of certain financial parameters. Man et al. (2002), Vargas and Rangel (2007) have observed that business performance is positively related with development of internal capabilities such as soft technology (methods and processes that support the firm) and hard technology (externally acquired equipment, in house development of machinery andinnovation in raw materials) and a strategy of continuous improvement, innovation and change. Other major challenges for SMEs are up gradation of technology (Kleindl, 2000), human resource development (Hudson et al., 2001), new product development (Sonia and Francisca, 2005) and finally managing its supply chain through collaboration and partnerships with customers, suppliers, distributors, competitors, and other organizations such as consulting firms and research centers (Soh and Roberts, 2005; Bennett and O'Kane, 2006). Vos (2005) has observed that managers of SMEs have poor skills in reflecting upon their companies strategically. SMEs often are oriented towards serving local niches or developing relatively narrow specializations (Urbonavicius, 2005). Major constraints on SMEs in meeting the challenges of competitiveness are: Inadequate technologies as well as other resources (Gunasekaran et al., 2001; Hashim and Wafa, 2002). Excessive cost of product development projects (Chorda et al., 2002). Lack of effective selling techniques and market research (Hashim and Wafa, 2002).Unable to meet the demand for multiple technological competencies (Muscatello et al., 2003; Narula, 2004), Information gap between marketing and production functions as well as lack of funds for implementing expensive software such as ERP system (Xiong et al., 2006). A large number of SMEs are operating with poor forecasting and planning systems and operate with long cycle times. This can lead to excess obsolete stock and eroding customer service levels (Gunasekaren et al., 2000). SMEs in manufacturing industry need to improve their production and material management systems (Ulusoy, 2003). Development of vendors is essential for this purpose.

Vendor development helps in improving the performance of not only buyers but also vendors (Humphreys et al., 2004). It was found that higher rated vendors emphasize process management and employee satisfaction to a greater degree than the lower rated vendors (Park et al., 2001). Different pressures on SMEs are conformance to quality, i.e. low-defect rates, product features or attributes, competitive price and performance (Corbett and Campbell-Hunt, 2002). According to Chiarvesio et al. (2004), a leading firm is characterized by dynamic strategic behavior in terms of innovation, relationship management with market and suppliers, internationalization processes, ability to organize and manage business networks, etc. According to Leachman et al. (2005), superior manufacturing performance leads to competitiveness. Capacity of a firm to maintain reliable and continuously improving business and manufacturing processes to meet above challenges appears to be a key condition for ensuring its competitiveness in the long run (Lagace and Bourgault, 2003). In such a challenging environment, the capacity of a firm to maintain reliable and continuously improving business and manufacturing processes appears to be a key condition for ensuring its sustainability in the long run (Denis and Bourgault, 2003). The successful implementation of TPM program can improve the manufacturing performance leading the organization to achieve competitive advantage and bring wide range of benefits (Badli, 2012). TPM can also be implemented in healthcare facility (Haddad and Jaaron, 2012). TPM implementation is not only improving OEE of large industries but also improve OEE of small scale industries by improving availability, performance and quality rate of machines (Jain et al., 2012). The management has to be patience enough to motivate the employees and watch for the results of TPM implementation (DOGRA et al., 2011).

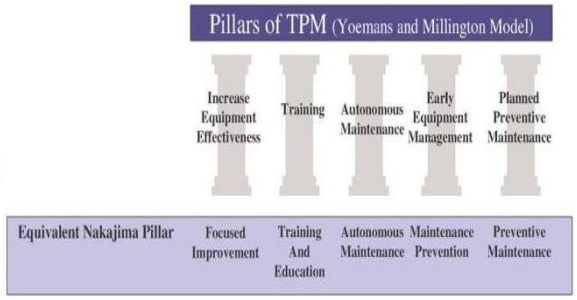
HISTORY OF TPM PILLARS

TPM activities are indicated and organized by 'pillars'. The number and naming of TPM pillars may differ slightly according to different authors. This model generally includes 8 pillars namely Focused Improvement, Autonomous Maintenance, Preventive Maintenance, Training & Education, Maintenance Prevention, Quality Maintenance, Administrative TPM and Safety & Environment. However, the most commonly accepted model is based on Nakajima's eight pillars***** (Nakajima 1984; Nakajima 1988), as presented in Figure 1. Some of the Western TPM practitioners have simplified the Nakajima model by eliminating or changing pillars. Figure 2 shows a five-pillar model given by (Yeomans and Millington 1997). Researcher (Yeomans and Millington) eliminates three pillars namely Quality maintenance, Administrative TPM and Safety & Environment and simplified Nakajima model in 1997. Another western practitioner called Steinbacher and Steinbacher have also simplified Western pillar model in 1993 as shown in figure 3. This model is known as Steinbacher and Steinbacher TPM model 1993. In this model, Training and Education is integral with other pillars rather than a stand-alone pillar and include one additional pillar as predictive maintenance as in the Nakajima Model. Society of Manufacturing Engineers in 1995 have developed a new model for SMEs which also includes 5 pillars namely Focused Improvement, Autonomous Maintenance, Quality Maintenance, Training & Education, Maintenance Prevention. This model is as shown in figure 4. This model is called SME model. Another TPM model developed in the 1960s which consists of 5S as a foundation and eight supporting activities sometimes referred to as pillars is called Traditional TPM model as shown in figure 5. It consists of five elements as Seiri (Sorting out the required or not required items); Seition (Systematic Arrangement of the required items); Seiso (Cleaniness); Seiketsu (Standardisation); Shitsuke (Self Discipline). The goal of 5S is to create a good work environment for working of manpower. 5S creates a foundation for well-running equipment. For example, in a clean and well-organized work environment, tools and parts are much easier to find, and it is also much easier to find emerging issues such as fluid leaks, material spills, and metal shavings from unexpected wear, hairline cracks in mechanisms, etc.



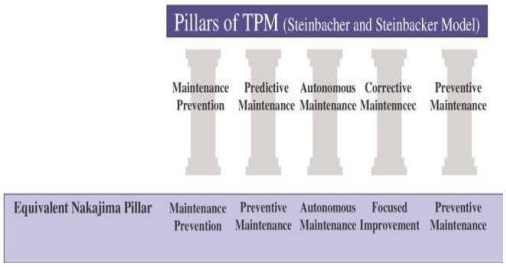
Source: TPM Pillars (Nakajima Model, 1988)

Figure 1



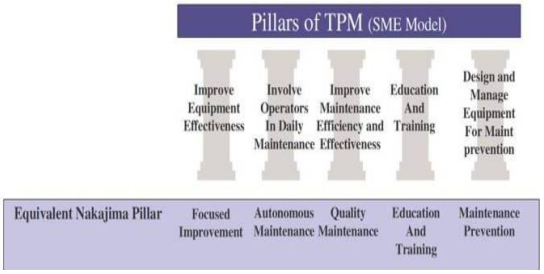
Source: TPM Pillars (Yoemans and Millington Model 1997)

Figure 2



Source: TPM Pillars (Steinbacher and Steinbacher Model 1993)

Figure 3



Source: TPM Pillars (SME Model)

Figure 4

Source: Traditional TPM model

Figure 5

THE PROPOSED TPM MODEL FOR INDIAN SMES

There are 5 primary phases of 5S for work place: sorting, straightening, systematic cleaning, standardizing, and sustaining (Hirano and Hiroyuki, 1995). Another 5 additional secondary phases of 5S for workers: safety, security, satisfaction, survives and Support is also used by authors in this proposed model as a foundation along with primary phases. Details of these all primary phases of 5S for work environment and additional secondary phases of 5S for workers are given below.

Sorting (Seiri)

Eliminate all unnecessary tools, parts, and instructions. Go through all tools, materials, and so forth in the plant and work area. Keep only essential items and eliminate what is not required, prioritizing things per requirements and keeping them in easily-accessible places. Everything else is stored or discarded.

Straightening or Setting in Order / Stabilize (Seiton)

There should be a place for everything and everything should be in its place. The place for each item should be clearly labeled or demarcated. Each tool, part, supply, or piece of equipment should be kept close to where it will be

used – in other words, straightening the flow path. *Seiton* is one of the features that distinguish 5S from "standardized cleanup". This phase can also be referred to as *Simplifying*.

Sweeping or Shining or Cleanliness / Systematic Cleaning (Seiso)

Clean the workspace and all equipment, and keep it clean, tidy and organized. At the end of each shift, clean the work area and be sure everything is restored to its place. This makes it easy to know what goes where and ensures that everything is where it belongs. Spills, leaks, and other messes also then become a visual signal for equipment or process steps that need attention.

Standardizing (Seiketsu)

Work practices should be consistent and standardized. All work stations for a particular job should be identical. All employees doing the same job should be able to work in any station with the same tools that are in the same location in every station. Everyone should know exactly what his or her responsibilities are for adhering to the first 3 S's.

Sustaining the Discipline or Self-Discipline (Shitsuke)

Maintain and review standards. Once the previous 4 S's have been established, they become the new way to operate. Maintain focus on this new way and do not allow a gradual decline back to the old ways. While thinking about the new way, also be thinking about yet better ways. When an issue arises such as a suggested improvement, a new way of working, a new tool or a new output requirement, review the first 4 S's and make changes as appropriate.

Safety

A sixth additional phase, "Safety", is also added in this model. This sixth "S" promotes safety to all employees in the organization which is compulsory now a days to motivate them.

Security

A seventh additional phase, "Security", is also added in this model. In order to leverage security as an investment rather than an expense, the seventh "S" identifies and addresses risks to key business categories including fixed assets, material, human capital, brand equity, intellectual property, information technology, assets-in-transit and the extended supply chain.

Satisfaction

An eighth additional phase, “Satisfaction”, is also included in this model. Employee Satisfaction and engagement in continuous improvement activities ensures the improvements will be sustained and improved upon. The Eighth waste – Non Utilized Intellect, Talent, and Resources can be the most damaging waste of all.

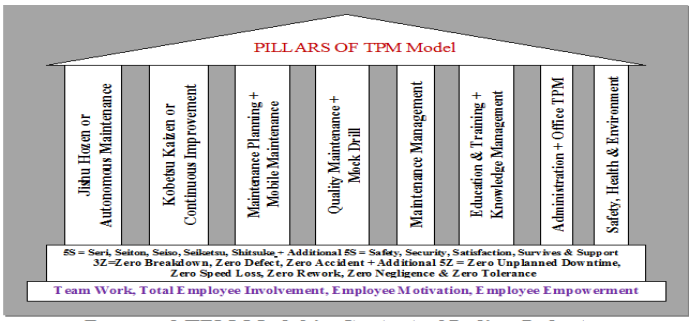
Survives

An ninths additional phase, “Survives”, is also included in this new model. Organizational must be capable to survive in this competitive global market which is only possible when they adopt new technology like TQM, TPM, Continuous Improvement, Total Employee Involvement, Employee Empowerment etc.

Support

An tenth additional phase, “Support”, is also included in this model. All the employees need support from their

top management. Management Support is always needed to motivate the employee to get the desired result.



Proposed TPM Model in Context of Indian Industry

Figure 6

Authors have also used some other elements as Zero Unplanned Downtime, Zero Speed Loss, Zero Rework, Zero Negligence and Zero Tolerance termed as 5Z in foundation along with primary 3Z as Zero Breakdown, Zero Defect, and Zero Accident. Unplanned down time means simply breakdown of machines which is the major loss of the industry have to be eliminate. Slow running of machines is called Speed loss and that should be zero. Product produced in the industry must be fault less or free from any deficiency and should satisfy the customer requirements. When any machine is not running properly during production in the industry then it is the responsibility of operator of that machine to do complain about that machine to maintenance department so that machine can repair and became ready for production as earlier as possible. When operator is not doing complain about his machine if machine is not running properly then it is called negligence. According to authors that negligence in the industry must be zero. Product produced in the industry must satisfy all the requirements of customer. It is called as the Zero tolerance. Team work, Total Employee Involvement and Employee Empowerment are also considered as important elements in the foundations in this proposed model by authors. These can be defined as.

Team Work

A team is defined as a group of people working together to achieve common objectives or goals. Teamwork is the cumulative actions of the team during which each member of the team subordinates his individual interests and opinions to fulfill the objectives or goals of the group. When individuals with a common interest, goal, attitude, need and perception come together, a team is formed. Individuals need to come and work together to form a team for the accomplishment of complicated tasks. In any organization, no one works alone. Every employee is a part of a team and works in close coordination with the team members to perform his level best and in turn benefit the organization. The team members should complement each other and come to each other's need whenever required. Teams can be formed anywhere, anytime whenever the task is little difficult and complicated.

Employee Empowerment

Empowerment is the process that provides an opening to the creative thinking of staff. It helps employee's motivation level. It gives the employees more power with the delegation of authority. It provides a chance to participate in the problem solving. The process makes the organizational structure less hierarchical and creating a supportive culture, enabling employees to make positive contributions to decision making. In order to create the empowered environment, three conditions are necessary-

- Everyone must understand the need for chance
- The system needs to change to the new paradigm

- The organization must enable its employees

Total Employee Involvement

Involving employees, empowering them, and bringing them into decision making process and also provide the opportunity for continuous process improvement. The untapped ideas, innovations, and creative thoughts of employees can make the difference between success and failure. Employee involvement improves quality and increases productivity, because:

- Employees are more capable to do anything for betterment of the organization.
- Employees can take better decisions by using their expert knowledge of the process.
- Employees are more likely to implement and support decisions.
- Employees are more capable to find out spot and pinpoint areas for improvement.
- Employees are more capable to take immediate corrective actions.
- Employee involvement reduces labour/management friction by encouraging more effective communication and cooperation.
- Employee involvement increases morale by creating feeling of belonging to the organization.
- Employees are better able to accept change because they control the work environment.
- Employees have an increased commitment to unit goals because they are involved.

As organizational culture begins the process change, resistance to this change will certainly be present. People will reduce resistance, especially when they see the benefits. Change is an ongoing process that must occur if an organization is to continue to exist in competitive world. People do not necessarily resist change; they resist being changed, and problems arise when a person's comfort zone is disturbed.

PILLAR -1

JISHU HOZEN (Autonomous Maintenance)

This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating.

Policy of Autonomous Maintenance

- Uninterrupted operation of equipments.
- Flexible operators to operate and maintain other equipments.
- Eliminating the defects at source through active employee participation.
- Focus on Kaizen and small group activities
- Stepwise implementation of JH activities.

JISHU HOZEN Targets

- Reduce oil consumption by 50%
- Reduce process time by 50%
- Increase use of JH by 50% (Lubrication / coolant / hydraulic)

Steps in JISHU HOZEN

- Preparation of employees.
- Initial cleaning of machines.
- Take counter measures
- Fix tentative JH standards
- General inspection
- Autonomous inspection
- Standardization and
- Autonomous management.

PILLAR-2

KAIZEN (Continuous Improvement)

"Kai" means change, and "Zen" means good (for the better). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are more effective in an organizational environment than a few improvements of large value. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well.

Kaizen Policy

- Practice concepts of zero losses in every sphere of activity.
- relentless pursuit to achieve cost reduction targets in all resources
- Relentless pursuit to improve over all plant equipment effectiveness.
- Extensive use of PM analysis as a tool for eliminating losses.
- Focus of easy handling of operators.

Kaizen Target

Achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost reduction.

Tools Used in Kaizen

- PM analysis
- Why - Why analysis
- Summary of losses
- Kaizen register
- Kaizen summary sheet.

PILLAR-3

MAINTENANCE PLANNING & MOBILE MAINTENANCE

It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This maintenance breaks down into 4 "families" or groups which were defined as.

- Preventive Maintenance
- Breakdown Maintenance
- Corrective Maintenance
- Maintenance Prevention

With Maintenance Planning, we can manage or plan which types of maintenance required for different types of failure in the organization. Sometimes we need breakdown maintenance instead of other maintenance program. In SMEs as well as in some large industries was using *Mobile Maintenance*. When few numbers of maintenance personal with a trolley in which some important tools, standard size nuts & bolts, screws, oils, grease, brushes, safety cloth and spanners and important spare parts etc. are moving on floor to do oiling, greasing, cleaning of machines regularly and also to do preventive maintenance so that unplanned down time of machines will reduced. Mobile maintenance is very important strategy especially in SMEs. Shop floor area of SMEs is small so that this small team can check and maintain each and every machine easily. Sometimes this mobile maintenance is sufficient to maintain machines at shop floor in small scale industry. These members of mobile maintenance team should also train the operators of different machines so that they can maintain their machines and minimize the unplanned down time.

Policy of Maintenance Planning & Mobile Maintenance

- Achieve and sustain availability of machines
- Optimize maintenance cost.
- Reduces spares inventory.
- Improve reliability and maintainability of machines.
- Reduce unplanned downtime of machines.

Target of Maintenance Planning & Mobile Maintenance

- Zero equipment failure and break down.

- Improve reliability and maintainability by 50 %
- Reduce maintenance cost by 20 %
- Increase productivity and quality of products
- Ensure availability of spares all the time.

Six Steps in Maintenance Planning

- Equipment evaluation and recoding present status.
- Restore deterioration and improve weakness.
- Building up information management system.
- Prepare time based information system, select equipment, parts and members and map out plan.
- Prepare predictive maintenance system by introducing equipment diagnostic techniques and
- Evaluation of planned maintenance.

PILLAR-4

QUALITY MAINTENANCE & MOCK DRILL

It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like Focused Improvement. We must understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, and then move to potential quality concerns. For doing Quality Maintenance, our staff should be trained to repair the machines or equipment effectively. Mock Drill is the process by which we can train our maintenance staff to repair the critical problems by giving training about same types of problems to them. ***Mock Drill*** means the rehearsal of maintenance process. This is the responsibility of senior manager to train their sub-ordinates about the maintenance process as well as for safety practices so that they will take a little bit time to repair the machines or take immediate action for fire etc. Mock Drill is the new concept by which we can reduce mean time to Repair (MTTR) and increase productivity. Mock Drill is the process to train the maintenance staff or operators to repair the equipment especially in Breakdown Maintenance. The phrase "mock drill" is a redundancy, because mock means an imitation, and drill means a practice, or "systematic training by multiple repetitions." So you wouldn't really have an "imitation" practice or rehearsal. The rehearsal is real, even if the emergency situation. So the drills are real, not "mock.". To be less redundant one could say "training drill," because that would signify that you were talking about a rehearsal for a performance or an emergency situation and not a tool designed to bore holes.

Policy of Quality Maintenance

- Defect free conditions and control of equipments
- QM activities to support quality assurance.
- Focus of prevention of defects at source
- Focus on poka-yoke. (fool proof system)
- In-line detection and segregation of defects.
- Effective implementation of operator quality assurance.

Target of Quality Maintenance

- Achieve and sustain customer complaints at zero
- Reduce in-process defects by 50 %
- Reduce cost of quality by 50 %.

Purpose of Mock Drill

- To reduce mean time to repair (MTTR)
- To improve productivity
- To reduce Breakdown time of machines
- To identify the problem in running machines by experience

Objectives of Mock Drill

- To evaluate effectiveness of the Emergency Action/Response Plan of the company.
- To evaluate the response of the key personals assigned as an Emergency Response Team Members and
- To evaluate the system deficiencies / deviation where the scope of improvement in Emergency Management System.

Scope of Mock Drill

- This drill covers all activities having fire hazard, all fire prone areas of all parts of the company.
- This drill prepares the employees for Emergency cases also.
- Maintenance personal can became capable to do maintenance of critical machines very easily.

PILLAR-5

MAINTENANCE MANAGEMENT

TPM provide a comprehensive company–wide approach to **maintenance management.** Thus it is necessary to analyze the **maintenance cost** in terms of production. Maintenance Management may be one of the Individual Pillar of TPM. Maintenance Management includes the costing of maintenance which is very important in SMEs. Maintenance manager must concentrate on the optimization of the maintenance cost. Maintenance schedule or chart must display in maintenance department also on individual machines.

Purpose of Maintenance Management

- To reduce the maintenance cost of equipments
- To give training to identify the actual problem in the machine so that they can take the right decision either to repair the part or change the part.
- To reduce the negligence by maintenance workers in the maintenance work so that part will either repair or change as earlier as possible and production loss will reduce.

Target of Maintenance Management

- Reduce (Mean Time to Repair) MTTR.
- Improve (Mean Time Between Failure) MTBF
- Reduce maintenance cost by 40 %

PILLAR-6

EDUCATION, TRAINING & KNOWLEDGE MANAGEMENT

Every industries either large or small needs multi-skilled and educated employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill and knowledge. Uneducated & Untrained employees are solving maintenance problems without knowing the root cause of the problem. Hence it become necessary to train and educates them. The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills is

Phase 1: Do not know.

Phase 2: Know the theory but cannot do.

Phase 3: Can do but cannot teach

Phase 4: Can do and also teach.

Owners of SMEs are always thinking that TPM can implement only in large industries due to lack of knowledge about TPM. Lack of knowledge is more dangerous than no knowledge. *Knowledge management* is very important in each field to know about that field. If you have knowledge about any approach then you can perform well. When owners of SMEs have knowledge about TPM implementation in SMEs and its direct or indirect benefits for the industries then owner can implement TPM in their industries. TPM can also be implemented in SMEs as per TPM club. TPM slogan and their benefits for company as well as employees must be display at different places on the shop floor. Owners must have knowledge about new technology in this competitive world.

Policy

- Focus on improvement of knowledge, skills and techniques.
- Creating a training environment for self learning based on felt needs.
- Training curriculum / tools /assessment etc conductive to employee revitalization
- Training to remove employee fatigue and make work enjoyable.

Target

- Achieve and sustain downtime due to want men at zero on critical machines.
- Achieve and sustain zero losses due to lack of knowledge / skills / techniques
- Aim for 100 % participation in suggestion scheme.

Steps in Educating and Training Activities

- Setting policies and priorities and checking present status of education and training.
- Establish of training system for operation and maintenance skill up gradation.
- Training the employees for upgrading the operation and maintenance skills.
- Preparation of training calendar.
- Kick-off of the system for training.
- Evaluation of activities and study of future approach.

PILLAR-7

ADMINISTRATION & OFFICE TPM

Administration of the company improves the efficiency and effectiveness of logistic and administrative functions. These logistic and support functions may have a significant impact on the performance of manufacturing production operations. Administrative and support departments are also playing vital role in the Manufacturing as well as other departments because this administration and office increase the productivity and reduce waste and losses. Administrative TPM focuses on identifying and eliminating effectiveness losses in administrative activities. The methodologies used in Focused Improvement, Autonomous Maintenance, Planned Maintenance, Maintenance Prevention, and Quality Maintenance are applied to administrative and support tasks and activity. Office and Administrative TPM should start after activating four other pillars of TPM (JH, KK, QM, MP). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation. Office TPM addresses twelve major losses. They are -

- Processing loss
- Cost loss including in areas such as procurement, accounts, marketing, sales leading to high inventories
- Communication loss
- Idle loss
- Set-up loss
- Accuracy loss
- Office equipment breakdown
- Communication channel breakdown, telephone and fax lines
- Time spent on retrieval of information
- Non availability of correct on line stock status
- Customer complaints due to logistics
- Expenses on emergency dispatches/purchases

How to Start Office TPM?

A senior person from one of the support functions e.g. Head of Finance, MIS, Purchase etc should be heading the sub-committee. Members representing all support functions and people from Production & Quality should be included in subcommittee. TPM co-ordinate plans and guides the subcommittee.

- Providing awareness about office TPM to all support departments
- Helping them to identify P, Q, C, D, S, M in each function in relation to plant performance
- Identify the scope for improvement in each function
- Collect relevant data
- Help them to solve problems in their circles
- Make up an activity board where progress is monitored on both sides results and actions along with Kaizens.
- Fan out to cover all employees and circles in all functions.

Kobetsu Kaizen Topics for Office TPM

- Inventory reduction
- Lead time reduction of critical processes
- Motion & space losses
- Retrieval time reduction.
- Equalizing the work load
- Improving the office efficiency by eliminating the time loss on retrieval of information, by achieving zero breakdown of office equipment like telephone and fax lines.

Administration, Office TPM and its Benefits

- Involvement of all people in support functions for focusing on better plant performance
- Better utilized work area
- Reduce repetitive work
- Reduced inventory levels in all parts of the supply chain
- Reduced administrative costs
- Reduced inventory carrying cost
- Reduction in number of files
- Reduction of overhead costs (to include cost of non-production/non capital equipment)
- Productivity of people in support functions
- Reduction in breakdown of office equipment
- Reduction of customer complaints due to logistics

- Reduction in expenses due to emergency dispatches/purchases
- Reduced manpower
- Clean and pleasant work environment.

P Q C D S M in Office TPM

P= Production output lost due to want of material, Manpower productivity, Production output lost due to want of tools.

Q= Mistakes in preparation of cheques, bills, invoices, payroll, Customer returns/warranty attributable to BOPs, Rejection/rework in BOP's/job work, Office area rework.

C =Buying cost/unit produced, Cost of logistics inbound/outbound, Cost of carrying inventory, Cost of communication, Demurrage costs.

D =Logistics losses (Delay in loading/unloading)

- Delay in delivery due to any of the support functions
- Delay in payments to suppliers
- Delay in information

S= Safety in material handling/stores/logistics, Safety of soft and hard data.

M = Number of kaizens in office areas.

PILLAR-8

SAFETY, HEALTH AND ENVIRONMENT

Target of SHE

- Zero accident,
- Zero health damage
- Zero fires.

In this pillar, we are focusing to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis. A committee is constituted for this pillar which comprises representative of officers as well as workers. The committee is headed by senior vice President (Technical). Safety is very important factor in the plant. Safety Manager is looking after the functions related to safety. To create awareness among employees various competitions like safety slogans, Quiz, Drama, Posters, etc. related to safety can be organized at regular intervals.

12 STEPS OF IMPLEMENTING TPM

Maintenance and reliability is the key to a successful TPM implementation in a core business strategy. Without top management support, TPM will be just another "flavor of the month." There are 12 steps of TPM implementation as given below.

Step 1: Announcement of TPM - Top management needs to create an environment that will support the introduction of TPM. Without the support of management, skepticism and resistance will kill the initiative.

Step 2: Launch a Formal Education Program - This program will inform and educate everyone in the organization about TPM activities, benefits, and the importance of contribution from everyone.

Step 3: Create an Organizational Support Structure. This group will promote and sustain TPM activities once they begin. Team-based activities are essential to a TPM effort. This group needs to include members from every level of the organization from management to the shop floor. This structure will promote communication and will guarantee everyone is working toward the same goals.

Step 4: Establish Basic TPM Policies and Quantifiable Goals. Analyze the existing conditions and set goals that are SMART: Specific, Measurable, Attainable, Realistic, and Time-based.

Step 5: Outline a Detailed Master Deployment Plan. This plan will identify what resources will be needed and when for training, equipment restoration and improvements, maintenance management systems and new technologies.

Step 6: TPM kick-off. Implementation will begin at this stage.

Step 7: Improve Effectiveness of Each Piece of Equipment. Project Teams will analyze each piece of equipment and make the necessary improvements.

Step 8: **Develop an Autonomous Maintenance Program for Operators.** Operators routine cleaning and inspection will help stabilize conditions and stop accelerated deterioration.

Step 9: Develop a Planned or Preventive Maintenance Program. Create a schedule for preventive maintenance on each piece of equipment.

Step 10: Conduct Training to Improve Operation and Maintenance Skills. Maintenance department will take on the role of teachers and guides to provide training, advice, and equipment information to the teams.

Step 11: Develop an Early Equipment Management Program. Apply preventive maintenance principles during the design process of equipment.

Step 12: Continuous Improvement - As in any Lean initiative the organization needs to develop a continuous improvement mindset.

Difficulties Faced in TPM Implementation

- Typically people show strong resistance to change.
- Many people treat it just another Program of the month without paying any focus and also doubt about the effectiveness.
- Not sufficient resources (people, money, time, etc.) and assistance provided
- Insufficient understanding of the methodology and philosophy by middle management
- TPM is not a quick fix approach, it involve cultural change to the ways we do things
- Departmental barrier existing within Business Unit
- Many people considered TPM activities as additional work/threat.

CONCLUSIONS

Now-a-days, More than 75% of total industries in India are of Small and Medium size industries. These are the heart of the large industries because large industries required and purchase most of the parts or component from small and medium size industries. Large scale industries need good quality products from SMEs. So, it is essential to produce good quality products and must be available at the right time & at right prize. To fulfill these requirements of large industries, competition becomes very high among SMEs. Financial benefits are also vital for the SMEs. In this present scenario these SMEs must adopt some advanced techniques like TPM. Literatures of this paper show that TPM implementation in SMEs is negligible so its implementation in India SMEs must be improved. Customer satisfaction is the challenge now-a-days for large industries. These requirements must be satisfy to become competitive in this competitive environment. Total Productive Maintenance is also one of the techniques which enables these SMEs competitive and fulfills the requirements of customers. In this study, authors have proposed a TPM model for SMEs which can be implemented in SMEs to enhance productivity, product quality and also to reduce losses. TPM can not only be implemented in industrial plants, but also in construction, building maintenance, transportation, and in a variety of other situations.

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